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ScienceDirect
Procedia IUTAM 2 (2011) 128–130
Procedia IUTAM
www.elsevier.com/locate/procedia

2011 Symposium on Human Body Dynamics

What I have learned from the great athletes

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Abstract

Having worked with several world champion athletes over the years, I have formed opinions as to what facilitates great performance. This paper summarizes a few observations of mechanical variables that characterize outstanding technique and performance results.

Peer-review under responsibility of John McPhee and József Kövecses
Keywords: Athletes; force; speed; excellence; effective mass; stiffness

1. Introduction

What makes great athletic performance? Is it strength, flexibility, speed? Having worked with many great athletes in the Olympic sports, basketball, football, mixed martial arts (MMA), weight lifting, and strongman, among others, my opinions have changed over the years. Evidence of how forces are directed through the body suggest that some essential elements of strength are missed in preparation for competition. For the majority of events, optimal strength is produced in "pulses". Speed is almost always enhanced with "proximal stiffness" and faster rates of muscle relaxation. Collision forces are optimized with enhancement of "effective mass". Examples of how these and other elements can be brought together in training are provided. The intent is to show how these performance variables work, together with how some of the great athletes incorporate them into training.

2. The force/speed paradox

When muscle contracts both force and stiffness is created. Force is needed to initiate and propel motion but stiffness slows the motion. How is great speed produced? Measuring the muscle activation

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doi:10.1016/j.piutam.2011.04.013

profiles in elite MMA athletes revealed a “double pulse” where a pule initiates motion, a relaxation phase occurs as the foot or fist increases closing velocity to the target, then a second pulse creates a final stiffening upon impact to enhance “effective mass” and transference of force to the target (McGill, Chaimberg, Frost and Fenwick, 2010). Elite performance was not defined by strength but by rate of muscle activation and relaxation. Relaxation rates were measured in this elite population to be up to 6 times faster than a control group of Graduate students (Hubrecht, Marshall and McGill, submitted).

World champion golfers exhibited similar pulse relaxation cycles. The downswing was initiated with a modest pulse of torso/hip muscle. Just before ball/club impact the rear leg gluteal muscles pulsed, while the torso musculature pulsed upon ball impact, only to be followed with a rapid relaxation to facilitate a fast follow-through of the club (McGill, 2009). Again, club speed was optimized not with muscle force but with impressive rate of relaxation to allow speed with effective mass being accomplished with a mid-swing pulse at ball contact.

An Olympic sprinter showed the same ability to pulse sequence muscle to propel a stiffened torso (McGill, 2009).

3. Proximal stiffness makes “impossible” tasks possible

It is not uncommon to hear that the “core”, meaning the muscles of the back, hips and abdominal wall, is the foundation of all strength. Professional strongman event competitors revealed why this is true. Consider the event known as the “superyoke carry” where the athlete places a crossbar across the shoulders of several hundred kilos and tries to walk the maximum distance. The gait biomechanists rarely examine the torso in any more detail than that of a rigid block. As a consequence they have concluded that the stance phase of gait requires a hip abduction moment on the support leg to stop the upper body from toppling in a frontal plane. We measured the hip abduction strength capability of a champion strongman to be approximately 500Nm – very impressive. Yet to perform the superyoke loaded to competitive weight required approximately 750Nm to hold the pelvic platform level to support the massive axial load down the spine (McGill, McDermott and Fenwick, 2008). He completed the task that was impossible given his deficient measured hip abduction strength. The solution to understanding lay in the monitoring of the lateral oblique muscle on the swing leg side (quadratus lumborum and abdominal obliques). They held the pelvis up. The eccentric lengthening of the deficient stance hip muscle was managed by taking short quick steps. We call this mechanism creating “proximal stiffness”.

Proximal stiffness magnifies the effect of muscle contraction of any muscle with an attachment to the torso and which crosses the ball and socket joints of the hips or shoulders. For example, during a tennis serve, stiffening the torso creates more motion of the distal limb via the latissimus dorsi – hence the guttural effusion or grunt. This potentiates the torso stiffness and thus a faster serving arm velocity. The same mechanism account for a better soccer kick, shot in hockey, punch or kick in MMA.

4. Effective mass and the creation of collision force

One cannot push rope, but pushing a rigid stone follows the laws of motion without energy loss. Likewise a great MMA fighter does not strike an opponent with the mass of the foot or fist but rather that of their entire body. Upon impact the body is stiffened with muscle pulses to create an effective mass of the strike equal to bodyweight plus the inertial forces of a rigid body. The same is observed in world class golfers, runners, and any other effective athlete who optimizes collision.

5. Superstiffness

There is exciting evidence that the distinction between “agonist” and “antagonist” muscles loses relevance for elite performance – rather all muscles are agonistic for one another. The muscles on one side of the joint assist one another through parallel cross-connections, and the fascial system transfers agonistic action to muscles on the other side of the joint. This is particularly evident in the torso. Adding the force and stiffness of individual muscles that have been surgically separated creates a sum but this sum is exceeded when the muscles remain intact (Brown and McGill, 2009). In this way a superstiffness occurs.

Athletes create conditions of superstiffness by tuning the elasticity of muscles, binding and weaving muscle/fascia complexes, creating pulses to conquer “sticking points” and redirecting neuronal overflow (McGill, 2009). Examples of these were demonstrated in the lecture. Further, training torso stiffness in a variety of movement patterns can be accomplished with a variety of exercises. However, is it often desirable to spare the joints from excessive loading – several examples were demonstrated during the lecture but have been summarized in McGill, 2009, and McGill 2010.

Acknowledgements

Given that this was a keynote presentation and the data presented covers years of synthesis, the author wishes to acknowledge some graduate student colleagues who played a role: S. Freeman, R. Patel, J. Yates, L. Marshall, C. Tampier, S. Howarth, K. Walker, S. Wang, N. Kavcic, R. Pruess, J. Scannell, J. Gunning, G. Lehman, L. Brereton, J. Peach, C. Axler, J. Callaghan, C. Sutarno, M. Mullender, L. Santaguida, J. Cholewicki, D. Frost, J. Flynn/Moreside, S. Brown, D. Bereznick, K. Ross, S. Grenier, V. Yingling. In addition the continual financial support of the Natural Science and Engineering Research Council of Canada is gratefully acknowledged.

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